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SILVICULTURE
Stand Improvement - PP
Pringle Falls P.S.P. 40

July 1, 1947

FIRST PROGRESS REPORT ON PONDEROSA PINE SPOT THINNING PLOT 40, PRINGLE FALLS EXPERIMENTAL FOREST

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Introduction

Pringle Falls plot 40 was established in October 1941 to serve as a spot thinning demonstration area and to test out the amount of release needed to establish selected crop trees as dominants in the stand. In the words of the establishment report answers to the following questions were sought:

(1) Is the amount of release now given sufficient to definitely establish released trees as dominant trees in the stand?

(2) How long does the effect of release last?

(3) Would the lesser or greater amount of release do as well or maybe better?

(4) May it be that an additional release should be given 5, 10, or more years after the initial release?

(5) How often and how much release must be administered to maintain the desirable rate of growth?

Location and Plot Description

Plot 40 is located in a pure, even-aged stand of ponderosa pine on the west slope of Pringle Butte less than one-fourth mile from the Pringle Butte road, on the trail that connects with the East Deschutes road. Although evenaged (53 years old in 1941) the stand certainly does not have that appearance, because on some spots the trees are densely crowded and badly stagnated, while on other areas thinned by surface fires growth has been maintained at a better rate. On one small area all trees have been completely burned off leaving nothing but brush to occupy the area.

Site

In 1937 the site, as indicated by the height of the second-growth stand, was VI-, but the few old veterans left in the surrounding area indicate IV. Site determinations made on plots 14-18, in an adjoining part of the same stand, gave values ranging from V to VII. It seems probable that the differences between the site as measured from the remnants of an older stand and the present one are caused by either the effects of stagnation, inaccuracies in the age-height-site curves, or both, and that the site still is potentially able to produce trees of the same size as the few remaining veterans of the earlier stand. The height-age relationship for the immature stand is believed to be an inaccurate measure of site, owing to the severe climatic cycle which prevailed from 1917 until 1941. Growth rate during this period was subnormal and it is believed that this deficiency has not been fully compensated by periods of greater than normal growth within the life span of the stand's age.

Field Procedure

The plot, 3.7 acres in area, is divided into six "columns" each 70.2 feet wide, and 16 "rows" each 23.4 feet wide. Within each of 93 of the 96 rectangles or subplots formed by the intersection of the row and column boundaries three crop trees were selected. The remaining three subplots fell on an area where there were no trees. Within each subplot each crop tree was at random assigned to one of the following treatments:

(1) Full crown release where the main crown was liberated from intervening branches of the surrounding trees, but no open space was intentionally created between the crop trees and the surrounding stand.

(2) Full crown release plus three to four feet of open space between the crown of the crop tree and the surrounding stand. Undergrowth of ceanothus and manzanita was also removed within the circle of release.

(3) No release.

The slash from pruning crop trees of their dead branches and the thinning was left where it fell.

The following data were obtained for each crop tree: D.B.H. to nearest tenth inch; total height to nearest half foot; height to live crown; crown class - dominant, codominant, or intermediate; form - good, medium, or poor; and vigor class - good, medium, or poor.

In addition, the number of trees cut out to release trees of treatments 1 and 2 were tallied by one-inch diameter classes. In general the work followed the design set up in "Instructions for Establishing Spot Thinning Demonstration Areas in the Ponderosa Pine Region of Oregon and Washington"

of August 8, 1938 by P. A. Briegleb and amended November 14, 1938 by the same author, and "Outline for Additional Experimentation in Spot Thinning" of April 26, 1941 by Theodore Kachin. A more complete description of the plot, its establishment, and site may be obtained from "Report of Establishment of Spot Thinning Plot No. 40, Pringle Falls Experimental Forest" of April 7, 1943 by Thornton T. Munger and Donald F. McKay, and "First Report on the Pringle Falls Thinning Plots Numbered 14, 15, 16, 17 and 18" of March 31, 1936 by Ernest L. Kolbe and W. H. Beeman.

The 1946 Examination

In December of 1946, Mowat, Howard, and Dahms remeasured the trees on this plot. Diameters were taken with a diameter tape just above the nail holding the tag; any nails too deeply imbedded in the wood were pulled. Heights up to about 30 feet were measured with a pole while those trees taller than 30 feet were measured with an Abney level and steel tape. All height measurements were taken to the nearest half-foot as before. In a few cases the earlier measurements were obviously in error, so in addition to this year's height an estimated height growth for the period was also recorded and used in height computations. Only 2 dead trees were found among the tagged group. One had been chopped down, evidently by mistake, at the time of thinning and the other was broken by an untagged tree as it fell.

As the examination proceeded the impression was gained that even though the distinction between amounts of crown release provided for the three treatments was very definite in most cases, still all must have shared to some degree the new root space created by the thinning because of the nearness of the trees of the three treatments. In a few cases it even appeared that all shared, to some extent, the crown release.

At the time of the examination the ground was covered with snow; therefore, no observations could be made regarding ground cover or slash decay, but a visit to the plot in the spring of 1947 showed that the needles had all fallen and snow had mashed the slash down close to the ground. No appreciable amount of decay, even in the small twigs, had yet taken place. However, because the volume of material on the ground was not great no undue fire hazard existed.

No additional thinning, as proposed in the plan, was made at this time because there had been hardly any visible closing in of the free crown space around the released trees. Very few branches had died in the 5-year period so that further pruning also did not seem worth-while.

Computations

The design of this experiment is such that the measure of results must be in terms of the growth and behavior of individual crop trees rather than the usual per-acre stand data. For this first growth period (1941-46) computations were made of increment of crop trees in diameter, in height,

and in basal area. The average tree diameters given in table 1 were figured by dividing total of all diameters in each group by number of trees rather than through basal area. It is apparent that for the plot as a whole the average d.b.h. and height of trees in each treatment group are nearly the same and, therefore, any differences in growth could be compared directly. However, much additional information may be gained by considering the relation of increment to initial diameter and height and the variations by subplots, such as are brought out in a covariance analysis.

The covariance type of analysis used (see table 2) follows the general outline suggested by P. A. Briegleb in his "Instructions for Establishing Spot Thinning Demonstration Areas in the Ponderosa Pine Region of Oregon and Washington" of August 8, 1938. The regressions of chart 1 were easily computed from figures available in this analysis. Only the analysis for diameter increment was fully computed, as it was then apparent that similar computations for basal area and for height could not be expected to show any more conclusive results. For comparison with covariance a simple variance analysis of diameter increment (appendix table A) was compiled. Other computations were made to test significance and show value of regression, as presented in table 3 and table B.

Results

Effect of Thinning Upon Diameter Growth. It is apparent from table 1 that thinning has had but a slight effect upon diameter growth during this first 5-year period. The average rate of diameter increment for treatment 1, the lighter degree of thinning, was 0.138 inches per year, almost the same as the rate of 0.140 inches for treatment 3, the check trees. The heavier release, treatment 2, did show a little higher average rate, 0.150 inches per year. When these rates are adjusted by means of regression to the basis of the same average diameter of tree, the light thinning shows a very slight advantage over the check. The variation among subplots, however, is so great that these differences are not of statistical significance, as shown both in the covariance analysis (table 2) and the simple analysis (table A). The failure to show significant results may be attributed mainly to the fact that sufficient time has not yet elapsed for the full effects of release to be evident. It is also possible that the check trees may have benefited somewhat from the new root space created by the thinning.

As basal area is a direct function of d.b.h., it shows approximately the same relative increments as the latter. It is evident from inspection of the height data in table 1 that height growth had no relation to thinning treatment.

The relation of diameter increment to initial (1941) diameter is shown graphically in chart 1. The slope of the regression lines shows that there is a strong relationship to diameter, but there is little difference between the lines for the three treatments.

Discussion of Statistical Analysis

Several other points of interest are shown in the variance analyses and other tables: (1) The difference between columns is shown in table 2 to have some significance. This is a reflection of the rather widely varying stand conditions in different parts of the plot, as previously mentioned. Other than indicating that the regression of increment on initial diameter is itself quite variable with location, this fact has no bearing of practical importance.

(2) The interactions, treatment with columns, treatment with rows, and columns with rows were tested and found to be non-significant; therefore, the degrees of freedom and sums of squares associated with them were added to those already assigned to error.

(3) Trees given the heavier degree of release seemed to show materially greater increment in so many cases that a special covariance analysis, as presented in table 3, was made to compare that group with the check group. Although this test showed that the difference more nearly approached significance than did table 2, it still fell short of the 5 percent level so cannot be considered conclusive.

(4) It might be questioned whether the use of the covariance type of analysis was really justified in this case. Thus, it is notable that the results shown in the simple variance analysis (appendix table A) are not greatly divergent from those of covariance table 2, especially as to the most important factor of treatment. This is because the average tree diameters for the three treatments are nearly alike and, therefore, adjusted growth figures are little different from the actual ones. This would not always be true, especially with a smaller sample. However, the analysis of error variance in table B shows a very significant "improvement in precision" in the experiment due to including regression in the analysis, so that it is probably worth-while. This "improvement" shows up more strongly in row and column variance; thus, the differences in increments among rows shown as highly significant in the simple analysis (table A) are very largely due to diameter differences (i.e., regression), as is indicated by the comparatively low error of estimate for rows in table 2. The corresponding variance for columns is likewise reduced, but not as much.

Conclusions

It can be seen from the results above that satisfactory answers have thus far not been obtained for any of the questions posed at the time of establishment. There is, however, some inconclusive evidence showing a slightly greater (7 percent greater) diameter growth rate for the more heavily thinned group as compared with the unthinned group. The lighter degree of thinning has so far produced no appreciable acceleration of growth. Judging from results on other ponderosa pine thinning plots it is expected that during the next 5-year period the effects of release may become more evident and a significant difference in growth rate may be shown.

Future Examinations

This plot should be examined again in the fall of 1951 and at regular 5-year intervals thereafter. As soon as it appears that the space created by thinning is substantially reduced by growth of crowns, half of the trees of the thinned groups, treatments 1 and 2, should be given additional release as contemplated in the original plan. It will also be of interest to compare the results of spot thinning, as done on plot 40, with complete thinning, as on adjacent plots 14-18. Which method will in the end be most effective in securing a dominant position in the stand for the final crop trees? If utilization becomes more intensive the question might also be asked: Which method will produce the greatest total volume and value of usable material, that is, usable thinnings plus final crop?

Table I. Average Diameters, Heights, and Increments per Tree (1941-1946) for Crop Trees Given Two Degrees of Thinning and Unthinned

Thinning treatment	Average d.b.h. (1941)	Average dia. increment	Adjusted diameter increment*	Average B.A. increment	Average height (1941)	Average height increment
	Inches	Inches	Inches	Sq. ft.	Feet	Feet
I - Moderate Release	5.64	.69	.70	.0489	27.4	2.1
II - Heavy Release	5.81	.75	.74	.0535	28.0	2.3
III - No release	5.81	.70	.69	.0494	28.6	2.6

* Growth adjusted by means of regression to that of the average sized tree for the entire group.

Table II. Periodic Diameter Increment

Analysis of Covariance and Test of Significance of Adjusted Means
(Interactions not significant; included in "error" term)

Source of variation	Degrees of freedom	Sums of squares & products D.B.H. Sx^2	Sxy	Dia. inc. Sy^2	Errors of estimate Sum of squares	Deg. of freedom	Mean square
Total	276	677.763	63.951	16.423	10.389	275	.038
Treatments	2	1.589	0.312	0.185	0.124	1	.124
Columns	5	79.723	5.373	0.828	0.466	4	.116
Rows	15	182.355	18.682	2.303	0.339	14	.028
Regression on Dia.	1						
Error	253	414.096	39.584	13.107	9.323	252	.037
Treatment & Error	255	415.685	39.896	13.292	9.465		
Difference for testing adjusted treatment means					.142	2	.071
Columns & Error	268	493.819	44.957	13.935	9.842		
Difference for testing adjusted column means					.519	5	.104

Tests for Significance

Treatments $F = .071/037 = 1.92$ $F_{.05} = 3.07$

Columns $F = 104/037 = 2.81$ $F_{.01} = 2.28$ $F_{.05} = 3.16$

Table III. Analysis of Covariance Between Most Heavily Thinned and Check Groups

Treatment	Degrees of freedom	Sums of squares & products			Errors of estimate	
		Sx^2	Sxy	Sy^2	Sum of squares	Deg. of freedom
Check	92	212.05	19.53	4.86	3.061	91
Heavily thinned	90	275.89	24.25	5.19	3.058	89
Average within treatments	182	487.94	43.78	10.05	6.122	181

Tests of Significance

Source of variation	Errors of Estimate: Degrees of freedom	Sums of squares	Mean square
Total	182	6.232	.034
Average within treatments	181	6.122	
Between adjusted means	1	.110	.110

$F = \frac{.110}{.034} = 3.24 \qquad F_{.05} = 3.90$

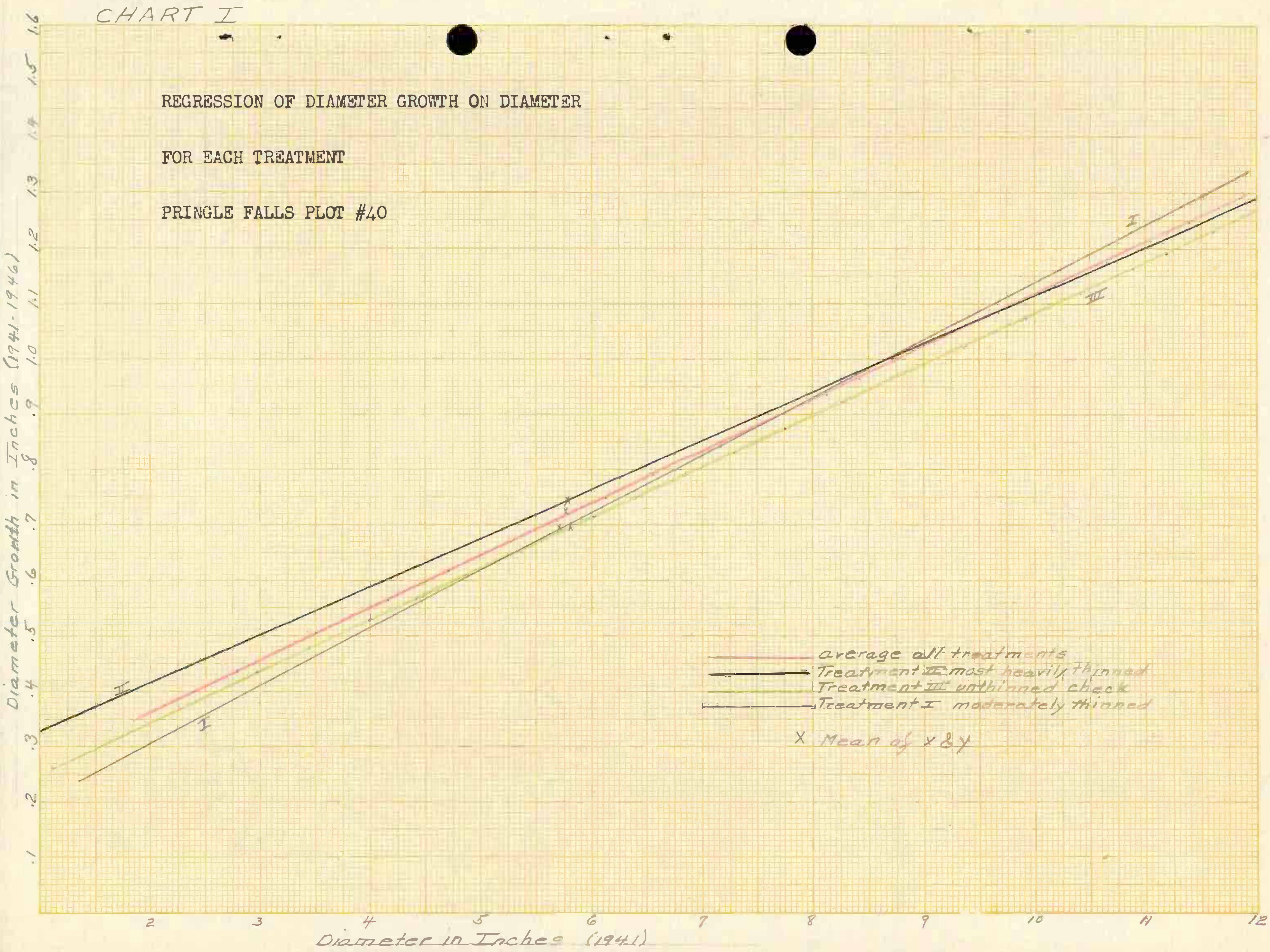
CHART I
REGRESSION OF DIAMETER GROWTH ON DIAMETER
FOR EACH TREATMENT
PRINGLE FALLS PLOT #40
average all treatments
Treatment II most heavily thinned
Treatment III unthinned check
Treatment I moderately thinned
X Mean of X & Y
I
II
III
Diameter Growth in Inches (1941-1946)
.1
.2
.3
.4
.5
.6
.7
.8
.9
1.0
1.1
1.2
1.3
1.5
1.6
Diameter in Inches (1941)
2
3
4
5
6
7
8
9
10
11
12

Appendix Table A. Analysis of Variance of Diameter Increment (5-year period 1941-46) on Crop Tree Thinning Plot No. 40, Pringle Falls Experimental Forest (Regression on diameter disregarded)

Source of Variation	Degrees of freedom	Sum of squares	Mean square	F Observed	F Tabular .05	F Tabular .01
Total	276	16.423	.0595			
Treatments	2	0.185	.0925	1.93	3.06	
Columns	5	0.828	.1656**	3.45	2.28	3.15
Rows	15	2.303	.1535**	3.20	1.74	2.17
Interactions: T x C	10	0.279	.0279			
T x R	30	1.322	.0431			
C x R	75	4.832	.0644	1.34	1.38	
T x R x C (Error)	139	6.674	.0480			

** Significant at odds of .01.

Appendix Table B. Analysis of Error of Variance - Diameter Increment (To show increase in precision of experiment by including regression)

Source of variation	Degrees of freedom	Sum of squares	Mean square
Error unadjusted (Sy^3)	253	13.107	.052
Reduction due to regression $\frac{(Sxy)^2}{Sx^2}$	1	3.784	3.784
Error adjusted	252	9.323	.037

F = 3.784/.037 = 102